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Offset Lithography Summary Report for Technical Support in Development of a Revised Ozone State Implementation Plan for Memphis, Tennessee

Pacific Environmental Services, Inc.
Durham, NC

Prepared for

Environmental Protection Agency
Atlanta, GA

Jun 85

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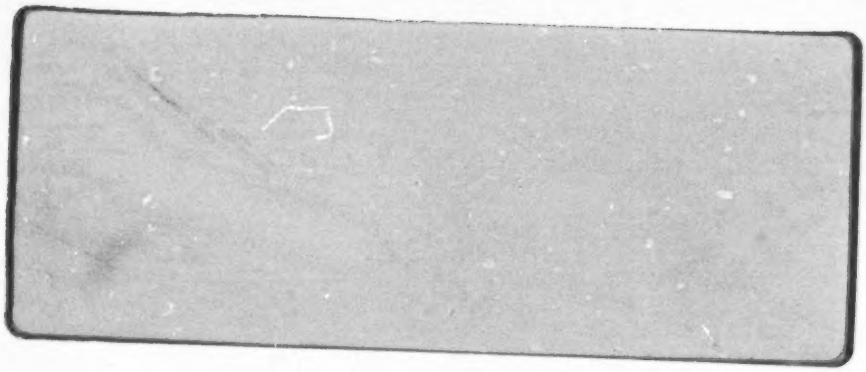
REPORT



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The document presents information on emissions of volatile organic compounds (VOC) from offset lithography facilities in Shelby County, Tennessee. Information is presented on the industry, emissions from offset press operations, emission control techniques, and the costs of reducing emissions. The control measures described in the document represent the presumptive norm or reasonably available control technology (RACT) that can be applied to existing offset lithography plants. Reasonably available control technology is defined as the lowest emission limit that a particular source is capable of achieving by application of control technology that is reasonably available considering technological and economic feasibility. It may require technology that has been applied to similar, but not necessarily identical, source categories. It is not intended that extensive research and development be conducted before a given control technology can be applied to the source. However, short-term evaluation programs are considered an appropriate technology forcing aspect of RACT.

KEYWORDS: *Lithography, *Air pollution control, *State implementation plan, *Volatile organic compounds.

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OFFSET LITHOGRAPHY SUMMARY REPORT FOR TECHNICAL SUPPORT IN DEVELOPMENT OF A REVISED OZONE STATE IMPLEMENTATION PLAN FOR MEMPHIS, TENNESSEE

Mr. Ron McHenry - Project Officer
U.S. Environmental Protection Agency
Region IV

EPA Contract No. 68-02-3887
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DISCLAIMER

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GLOSSARY

Isopropanol substitute	-	proprietary compounds developed to reduce or eliminate alcohols used in offset fountain solutions.
Dampening Aid	-	an organic chemical or surfactant, usually isopranol (isopropyl alcohol), which facilitates the use of continuous flow dampening systems.
Etchant in lithography	-	solution of various chemicals used to keep the non-printing areas capable of being wet by water and not by inks.
Fountain Solution	-	a solution of water, gum arabic, etchant, and surfactants used for wetting lithographic press plates.
Gum Arabic	-	solution of a gum derived from Acacia trees used to desensitize or remove any affinity for ink in the non-printing areas of lithographic plates.
Heatset	-	refers to a class of web-offset lithography which requires a heated dryer to evaporate the ink oils from printing inks.
Lithography	-	printing process in which the printing and non-printing surfaces are on the same plane as opposed to raised or depressed surfaces.
Offset	-	refers to a process which transfers an image from plate to a rubber blanket cylinder before transfer to the substrate surface to be printed.

GLOSSARY (concluded)

Substrate - the medium being printed, for example, paper or paper board.

Web - refers to the substrate printed in continuous roll-fed printing presses.

1.0 INTRODUCTION AND SUMMARY

This document presents information on emissions of volatile organic compounds (VOC) from offset lithography facilities in Shelby County, Tennessee. Information is presented on the industry, emissions from offset press operations, emission control techniques, and the costs of reducing emissions. Sources of information included plant visits, the 1985 Memphis-Shelby County VOC Emissions Inventory, professional literature, EPA publications, and communication with pressmen, industry trade association, and vendors of alcohol-extenders.

The control measures described in this document represent the presumptive norm or reasonably available control technology (RACT) that can be applied to existing offset lithography plants. Reasonably available control technology is defined as the lowest emission limit that a particular source is capable of achieving by application of control technology that is reasonably available considering technological and economic feasibility. It may require technology that has been applied to similar, but not necessarily identical, source categories. It is not intended that extensive research and development be conducted before a given control technology can be applied to the source. However, short-term evaluation programs are considered an appropriate technology forcing aspect of RACT.

Reasonably available control technology for offset lithography includes the use of a fountain solution in press dampening systems comprising less than 10 weight percent VOC. Alcohol-extenders are readily available that enable presses to utilize significantly reduced levels of isopropyl alcohol in the fountain solution, resulting in at least a 50 percent reduction in VOC emissions from the dampening system and improved plant safety at reasonable cost.

2.0 PROCESSES AND POLLUTANT EMISSIONS

2.1 INDUSTRY DESCRIPTION

The printing or graphic arts industry is comprised of about 40,000 establishments printing newspaper, magazines, books, business forms, catalogs, floor and wall coverings, and fabrics. This diverse industry is characterized by a large number of small plants, with approximately 80 percent of commercial printing plants employing fewer than 20 people each. About half of the establishments are "captive" or in-house printing services in non-printing industries.[1,2] An example of a captive printing operation in Shelby County, Tennessee, is that of Plough, Inc., a manufacturer of several hundred household products. An example of a merchant printing facility in Shelby County is Eastex Packaging Company which prints packaging material for a variety of customers.[3] There are 10 printing facilities in Shelby County.[4]

This document is concerned with only those facilities that use the offset lithography process. Lithography is one of the four major printing processes: (1) lithography; (2) letterpress; (3) gravure; and (4) screen printing. Each of these processes is described in the following section, with emphasis upon lithography.

2.2 PROCESS DESCRIPTION

2.2.1 Overview of Printing Processes[1]

Lithography is a planographic method of printing. The printing and non-printing areas are essentially in the same plane on the surface of a thin metal plate. The distinction between the areas is maintained chemically. The term "offset" has become synonymous with lithography and refers to a process which transfers an image from the plate to a rubber blanket before transfer to the printed substrate.

Letterpress is the original printing process, in which ink is applied to a raised image surface and transferred to the print surface. Flexography is a type of letterpress process in which the letterpress plates are rubber. In gravure printing, ink is transferred directly to the printing surface from a recessed image area. The ink is scraped off the non-image area. When the process is roll fed, it is known as

rotogravure. In screen printing, a fine screen is used as the image area and non-image areas are marked off. Inks are forced through the screen pores of the image area onto the print surface.

2.2.2 Offset Presses

There are several variations of offset presses. One distinction concerns the substrate to be printed. The substrate may be fed to the offset press in sheets or from a continuous roll referred to as a "web." The latter are called web-offset presses. A second distinction concerns the type of ink used. "Heatset" refers to offset presses that require a heated dryer to solidify (set) the printing ink as opposed to other offset presses that use inks that dry by absorption and by oxidation.

2.2.3 Offset Printing Process

As mentioned in Subsection 2.2.1, lithography is unique in that image and non-image surfaces of the printing plate are in the same plane. The image area of a lithographic plate is made of a material that is ink-receptive and water repellant, whereas the non-image area is made of a material which can be made water-receptive. The image plate is wrapped around the plate cylinder. In every revolution of the lithographic press:

(1) the plate is wet by a dampening system with an aqueous solution, called a fountain solution;
(2) ink is applied to the plate adhering only to the image area;
(3) the ink is transferred or offset to a rubber-covered blanket cylinder; and
(4) the rubber blanket transfers the inked image to the printing substrate (e.g., paper).[5,6]

A typical inking system for an offset lithographic printing unit is shown in Figure 2-1. The inking system performs the following functions: (1) "work" the ink from a gel-like consistency to a semi-liquid state; (2) distribute an even thin film of ink around all of the form rollers; (3) deposit a uniformly thin film of ink on the image area; (4) pick up fountain solution from the image plate and emulsify some of it into the ink; and (5) pick up loose particles of foreign matter from the image plate, and hold them in suspension until the entire system is cleaned.[7]

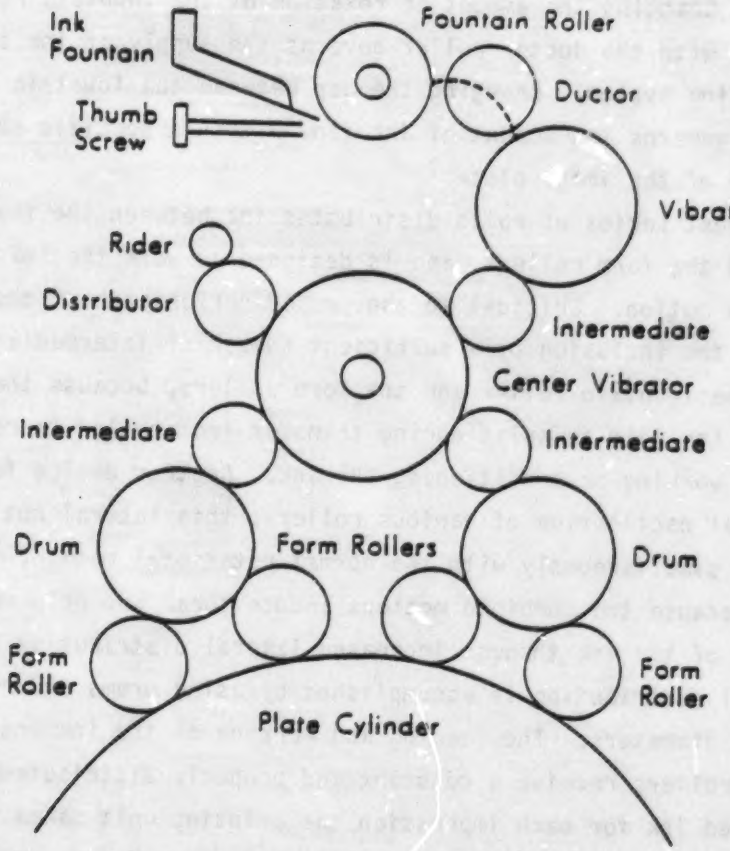


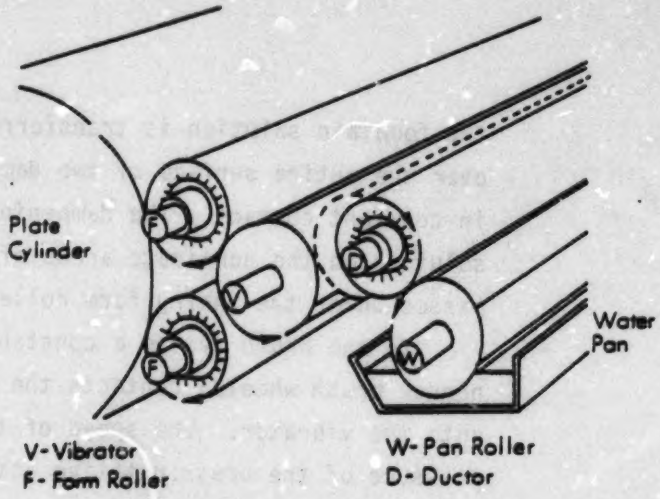
Figure 2-1. Schematic of a Typical Inking System.

The ink fountain is a reservoir of ink. The roller nearest the ink fountain is called the fountain roller. A blade which extends from the bottom of the ink fountain to very close to the fountain roller can be adjusted to vary the gap between the blade and the roller. The fountain roller rotates intermittently against the blade, and draws ink through this gap. As the fountain roller rotates, a resilient ductor presses against it and picks up ink that has been drawn from the ink fountain. Changing the amount of rotation of the fountain roller while in contact with the ductor roller governs the supply of ink across the entire inking system. Changing the gap between the fountain roller and the blade governs the amount of ink flow within a specific area along the length of the image plate.[7]

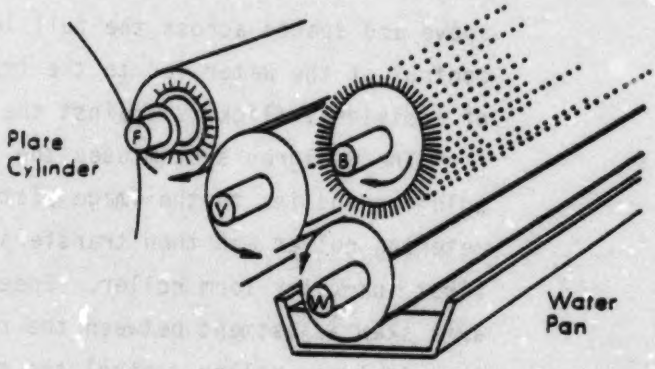
The next series of rolls distributes ink between the fountain roller and the form rollers, and is designed to work the ink by imparting energy and motion. Critical to the proper performance of the inking system is the inclusion of a sufficient number of intermediate rollers between the fountain roller and the form rollers, because the number of times the ink film is split during transfer from roller to roller is a factor in working or conditioning the ink. Another design feature is the lateral oscillation of various rollers; this lateral motion, occurring simultaneously with the normal rotational motion, helps work the ink because the combined motions induce shear and help reduce "ridging" of the ink through increased lateral distribution of ink. Rotational distribution is accomplished by using drums and rollers of differing diameters. The feeding and working of the ink ensures that the form rollers receive a constant and properly distributed supply of conditioned ink for each impression the printing unit makes.[7]

There are many available dampening systems. Three commonly used systems are shown in Figure 2-2. A conventional dampening system has four basic components: the water pan, a ductor, a metal vibrator, and form rollers. In the water pan (the fountain), either a brass, chrome-plated, or cloth-covered pan roller rotates and picks up fountain solution. The ductor, covered with a fairly thick absorbent cloth (molleton), intermittently contacts the pan roller and soaks up fountain solution from the pan roller. The ductor oscillates between the pan roller and a vibrator. When the ductor contacts the vibrator some of

Conventional Dampening System



Brush Dampening System



Dahlgren Dampening System

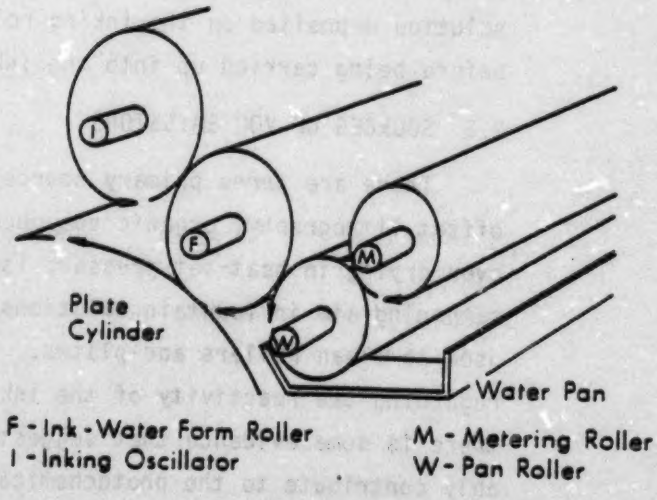


Figure 2-2. Schematic of Offset Dampening Systems.

the fountain solution is transferred and spread by the vibrator evenly over the entire surface of two dampening form rollers with which it is in constant contact. The dampening form rollers deposit fountain solution on the non-image areas of the image plate just before it passes under the inking form rollers.[7]

In the brush system a constantly revolving brush (or assembly of narrow brush wheels) contacts the pan roller and flicks fountain solution onto the vibrator. The speed of the motor-driven pan roller and the pressure of the brush rotating against the pan roller are variable to permit control of the amount of water distributed to the dampening form roller. One adaptation of this system has "flicker" fingers mounted above and spaced across the full length of the brush to achieve zonal control of the water fed to the image plate by adjusting the pressure of individual flickers against the constantly rotating brush.[6]

The Dahlgren system uses the inking system to carry both fountain solution and ink to the image plate. A steel pan roller contacts a metering roller and then transfers a film of fountain solution to the first ink-water form roller. Speed control of the pan roller and axis skew adjustment between the rubber-covered metering roller and the steel pan roller control the supply of fountain solution to the first ink-water form roller. The rotation direction of the plate cylinder in relation to the inking oscillator enables the fountain solution deposited on the inking rollers to contact the image plate before being carried up into the inking system.[7]

2.3 SOURCES OF VOC EMISSIONS

There are three primary sources of VOC emissions associated with offset lithography; organic components to inks that may volatilize upon oven drying in heat-set presses; isopropyl alcohol, widely used as a dampening aid in fountain solutions; and organic compounds that may be used to clean rollers and plates. There remains, however, a controversy regarding the reactivity of the ink oil used in heat-set presses and there is some evidence that suggests that printing inks do not appreciably contribute to the photochemical production of ozone.[8] Therefore, this document does not consider potential emissions from printing inks. Furthermore, several offset lithograph presses in Shelby County,

Tennessee, do not use heat-set inks, rather inks that dry by oxidation (the organic components of the ink do not volatilize). The following subsections discuss emissions from the fountain solution and cleaning solvents.

2.3.1 Fountain Solutions

Fountain solutions used in offset presses are composed primarily of water but also contain a mixture of salts and acids (buffered so as to maintain pH at 4.5 to 6), gum arabic, and a dampening aid.[5,9] Isopropyl alcohol is widely used as a dampening aid in fountain solutions, although various detergents, surfactants, and proprietary chemicals are also used. The isopropyl alcohol concentration in the fountain solution is usually maintained at about 20 weight percent. However, the concentrations may vary where manual makeup is used as the alcohol evaporates.

The role of isopropyl alcohol as a dampening aid is not fully understood. The alcohol reduces the surface tension of the fountain solution and, thereby, improves the transfer of the fountain solution across the printing plate.[5] It is also widely acknowledged that isopropyl alcohol enables pressmen to maintain print quality despite minor press problems (e.g., improperly set rollers).[8,10,11,12]

Emissions of VOC result as isopropyl alcohol evaporates throughout the dampening system. Isopropyl alcohol is added automatically or manually to covered mixing tanks from which the fountain solution is pumped to the water pans (shown in Figure 2-2) for each printing stack. Evaporation occurs from the waterpans, rollers, plates, and substrate releasing VOC into the press room. Heat-set presses could also release VOC (isopropyl alcohol) to the atmosphere from dryer exhaust vents.

2.3.2 Cleaning Solvents

Organic compounds are used as solvents to remove periodic buildup of printing inks and oils from press equipment. Cleaning is typically accomplished once or twice per shift by wiping equipment with solvent-laden rags. Cleaning solvents are dispensed from 55-gallon drums (or other large containers) into smaller one- to five-gallon safety containers which are then kept near the presses until needed. The cleaning compounds may comprise a single solvent (e.g., VM and P naphtha,

kerosene), a combination of solvents, or two or more different solvents used sequentially.[14] Emissions of VOC results from the evaporation of the cleaning solvents from the press equipment, from solvent-laden cleaning rags, and from solvent storage containers. Soiled rags may be kept in closed containers until they are sent to a laundry for cleaning.

2.4 MODEL PLANT

This section presents a model offset printing plant as a basis for estimating baseline emissions and RACT environmental and cost impacts. The Model Plant chosen is representative of a printing facility using oxidation inks and a fountain solution containing 20 weight percent isopropyl alcohol. Plant parameters are summarized in Table 2-1. Annual emissions of VOC from the Model Plant are presented in Table 2-2. Annual emissions of VOC from the Model Plant are estimated at 31.5 Mg/yr (34.8 tons/yr). Annual emissions from offset printing plants in Shelby County range from about 13 to 91 Mg (14 to 100 tons).[4]

TABLE 2-1. MODEL PLANT PARAMETERS

Types of Presses:[a]	1 two-color press
	1 six-color press
	2 five-color presses
Annual isopropyl alcohol usage[b,c]	50,000 liters (13,210 gallons)
Annual isopropyl alcohol disposal[d]	12,500 liters (3,302 gallons)
Annual cleaning solvent usage	2,500 liters (660 gallons)
Annual operating hours[e]	6,000

[a]For simplification, the Model Plant assumes no difference on RACT impacts of web- or sheet-fed presses, or whether heat-set or oxidation inks are used.

[b]Based on a fountain solution containing 20 weight percent isopropyl alcohol.

[c]From Reference 16.

[d]Based on 25 percent of alcohol usage recovered from waste disposal. Reference 15.

[e]Based on three shifts 250 days per year.

TABLE 2-2. MODEL PLANT EMISSIONS

Emissions Source	Annual Emissions Mg/yr	Tons/yr
Dampening system[a]	29.4	32.5
Equipment cleaning[b]	2.1	2.3
Total Emissions	31.5	34.8

[a]Calculated as total alcohol usage minus recovered alcohol for disposal.

$$(50{,}000\ \text{l/yr} - 12{,}500\ \text{l/yr}) \frac{0.7855\ \text{kg}}{\text{l isopropyl alcohol}} \frac{\text{Mg}}{1{,}000\ \text{kg}}$$

= 29.4 Mg/yr.

Treatment of ink-contaminated fountain solutions varies from plant to plant: (1) disposal in plant sanitary system; (2) shipment by drums to a hazardous landfill; or (3) incineration. References 16 and 17. For the purpose of estimating plant emissions, recovered fountain solution is assumed not to contribute to VOC emissions.

[b]Based on a cleaning solution comprised of aliphatic and aromatic hydrocarbons with specific gravity of 0.85 g/ml, and 100 weight percent VOC. Calculated as:

(2,500 l) (0.85 Kg/l) (1 Mg/1,000 Kg) = 2.1 Mg/yr

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3.0 EMISSION CONTROL TECHNIQUES

This chapter discusses control techniques that may be used to achieve significant emission reductions from offset presses in Shelby County, Tennessee. The focus of this chapter is on the use of "alcohol-substitutes," compounds that enable offset presses to operate with reduced alcohol or no alcohol in the fountain solution. Alcohol substitutes are discussed in Section 3.1. Conventional techniques for controlling VOC emissions are not widely applicable to offset presses because of: (1) frequent maintenance of press equipment; (2) large areas over which volatilization of VOC occurs; (3) and the importance of maintaining pressroom humidity and temperature preclude the use of hooding to capture VOC emissions and controlling these emissions in a VOC control device (e.g., carbon adsorber or incinerator). Other work practices that would minimize VOC emissions from offset presses are discussed in Section 3.2.

3.1 FOUNTAIN SOLUTION

Volatile organic compounds are frequently used in fountain solutions as dampening aids in offset printing. A common dampening aid is isopropyl alcohol. In recent years printers have been motivated to find substitutes for isopropyl alcohol in the fountain solution due to periods of short supply, to reduce costs, and to limit personnel exposure to isopropyl alcohol in the pressroom. As a result, substitute dampening aids have been developed by several firms. Firms that market isopropyl alcohol substitutes are listed in Table 3-1.

The composition of most isopropyl alcohol substitutes developed for use in fountain solutions is proprietary. Many are based on compounds called polyols (e.g., ethylene glycol and glycol ethers), which are chemically similar to isopropyl alcohol but more complex in chemical structure. Substitutes for isopropyl alcohol generally have a vapor pressure of less than 690 Pascals (0.1 psia) at 15.5°C (60°F), and are typically used in concentrations of about 2 weight percent or less in fountain solutions. Accordingly, the rates of evaporation of isopropyl alcohol substitutes are significantly less than the rate of evaporation of isopropyl alcohol.

TABLE 3-1. ISOPROPYL ALCOHOL SUBSTITUTES

Company/Location	Product
Roberts and Porter, Inc.[a] Chicago, Illinois	Isogon, Isofount
RBP Chemical Corporation[b] Milwaukee, Wisconsin	Aquanol 300
Printer's Service[c] Newark, New Jersey	Techfount
Roso Research Laboratory[d] Lake Bluff, Illinois	RV 1000 KST 500 ASM 3

[a]Reference 1.

[b]Reference 2.

[c]Reference 3.

[d]Reference 4.

The use of isopropyl alcohol substitutes has found acceptance in the printing industry where management has rigorously promoted their usage. However, many pressmen prefer to use isopropyl alcohol and would be reluctant to use alcohol substitutes because of the latitude in maintaining print quality that isopropyl alcohol offers. Nevertheless, several hundred offset printing plants are using alcohol substitutes in their fountain solution. A few companies using alcohol substitutes are listed in Table 3-2.

Reduction of high volatility organic compounds (i.e., isopropyl alcohol) used as dampening aids in fountain solutions could achieve a substantial reduction in VOC emissions in Shelby County, Tennessee. Assuming complete elimination of isopropyl alcohol from the Model Plant, presented in Section 2.4, emissions from the fountain solution would be reduced from 29.4 Mg/yr (32.5 tons/yr) to about 2.9 Mg/yr (3.2 tons/yr), about a 90 percent emission reduction.

It is possible, however, that some offset presses would not easily make a transition from running 20 weight percent to no isopropyl alcohol in the fountain solution. Older, less flexible rollers require more pressure to print properly and alcohol substitutes may have too high a viscosity to properly pass through the roller systems under high pressures.[8] Alcohol substitute vendors and representatives of the Graphic Arts Technical Foundation recommend a phased reduction because pressmen will have to learn to adjust the presses when operating with reduced levels of isopropyl alcohol. As much as 10 weight percent alcohol may be necessary during a transition period to maintain print quality.[1,5,6,7,9]

3.2 WORK PRACTICES

Another approach to controlling evaporative losses of isopropyl alcohol from dampening systems is through the use of refrigeration equipment to lower the fountain solution temperature and, hence, rate of evaporation. Fountain solution refrigeration equipment has become widespread as a means of maintaining print quality, particularly during summer months. Variations in fountain solution temperature affect the fountain solution viscosity (viscosity decreases with increasing temperature) and, consequently press performance. Extra cooling of the

TABLE 3-2. OFFSET PRINTING COMPANIES USING ISOPROPYL ALCOHOL SUBSTITUTES[6]

American Greeting Cards
Concord Lithography - Concord, New Hampshire
MCR
Burroughs
Duplex Products
Ripley Graphics - Ripley, Tennessee
Major Business Forms - Hillsborough, North Carolina
Louis Business Forms - Jackson, Florida
Better Business Forms - Tampa, Florida
NCR - Corbus, Kentucky
Four largest printing companies in Japan

fountain solution to lower-than-normal temperatures, 4.4 to 10°C (40 to 50°F) will reduce overall isopropyl alcohol consumption by as much as a factor of 2. Refrigeration of fountain solutions with alcohol substitutes will also improve press performance.[10]

A second work practice that would reduce VOC emissions from offset presses includes the use of water miscible cleaning compounds. Although these compounds are themselves nearly 100 percent volatile organic compounds, they are applied diluted with water to between 20 to 30 percent by volume. Hence, the water miscible cleaning compounds represent a theoretical reduction in the amount of cleaning solvents used. Vendors of these compounds claim improved cleaning qualities (e.g., improved removal of built-up glaze on rollers and blankets from paper or starch dust) and competitive overall costs than with using conventional cleaning compounds.[11-13]

A third work practice pertains to the transport and storage of isopropyl alcohol and organic cleaning compounds. The dampening system mixing tanks can be covered to minimize evaporation of isopropyl alcohol. Cleaning solvents can be transported and maintained in closed safety containers. Also, visual inspection can detect leaks from valves and pumps used to transport isopropyl alcohol from bulk storage to mixing tanks and the fountain solution to the dampening system. Repair of a leaking pump, for example, may achieve an emission reduction of 0.425 kg/hr (0.9 lb/hr).[14]

3.3 REFERENCES

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14. Fugitive Emission Sources of Organic Compounds -- Additional Information on Emissions, Emission Reductions, and Costs. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA-450/3-82-010. April 1982. p. 2-62.

4.0 ENVIRONMENTAL ANALYSIS OF RACT

This chapter discusses the environmental impacts that would result from implementing reasonably available control technology (RACT), which is presented in Section 4.1. The primary emphasis is a quantitative assessment of VOC emissions in the absence of RACT (baseline emissions) and after implementation of RACT. The impacts of RACT upon water pollution, solid waste, and energy consumption are also addressed in this chapter.

4.1 REASONABLY AVAILABLE CONTROL TECHNOLOGY (RACT)

Reasonably available control technology for offset printing plants in Shelby County, Tennessee, consist of limiting the amount of VOC in dampening system fountain solutions to 10 weight percent. In addition plants would be required to submit a twelve-month program to achieve further emission reductions. Included in the plan would be strategies to demonstrate the equivalent emission reduction to 5 weight percent VOC in the fountain solution and other strategies for demonstrating the feasibility of achieving 100 percent alcohol substitution. These strategies would be demonstrated on at least one offset printing press per printing plant. RACT also includes the storage of VOC compounds in closed containers and the prohibition of leaks of any VOC or VOC-containing material from an offset press or its associated equipment.

4.2 AIR POLLUTION

Implementation of RACT would reduce VOC emissions from offset printing plants resulting in a significant beneficial impact on air pollution. The emission reduction is the difference between the amount of emissions before RACT is implemented and after RACT is implemented as given in Table 4-1. During the first year of implementation of RACT, emissions from offset presses fountain solutions would be reduced between 50 and 90 percent or by an overall plant emission reduction between 47 and 84 percent. Emission reductions from the Model Plant presented in Section 2.4 would be between 15 Mg/yr to 26 Mg/yr (16.2 tons/yr to 29.3 tons/yr). Total estimated VOC emission reductions from implementing RACT in Shelby County can be estimated by applying the above RACT

TABLE 4-1. RACT EMISSION REDUCTIONS

Scenario	Emissions Reduction, Percent[a]	Model Plant Emission Reduction, Mg/yr (tons/yr)[b]	Shelby County Emission Reduction, Mg/yr (tons/yr)[b]
Before RACT	-	31.5 (34.7)[c]	150 (166)[d]
After RACT			
10 wt % VOC	47	15 (16)	71 (78)
5 wt % VOC	84	26 (29)	126 (139)

[a]The percent emission reduction is calculated from the model plant presented in Tables 2-1 and 2-2. For example, emissions from the dampening solution upon decreasing the isopropyl alcohol content from 20 weight percent to 10 percent would have an overall plant emission reduction of:

$$\text{Percent Rediction} = 1 - \frac{\text{After RACT Emissions}}{\text{Before RACT Emissions}}$$

where after RACT emissions =
= Total Model Plant Emissions Before RACT - Dampening System Emissions After RACT

= 31.5 Mg/yr - ((0.5)(29.4 Mg/yr))
= 16.8 Mg/yr

therefore, the percent reduction = 1- ((16.8 Mg/yr)/(31.5 Mg/yr)
= 47 percent

[b]Calcualted as: Before RACT Emissions x Percent Emissions Reduction

[c]From Table 2-2.

[d]From Reference 1.

control effectiveness to existing levels of emissions. Based on an estimated 150 Mg VOC (166 tons) per year from offset printing in Shelby County, RACT would achieve an annual emission reduction between 71 and 126 Mg VOC (78 and 139 tons).[1]

4.3 WATER POLLUTION

Implementation of RACT would not have a significant impact upon water pollution. A reduction of isopropyl alcohol content in fountain solutions would also reduce the contaminants in press wastewater (ink-contaminated fountain solution). The replacement of isopropyl alcohol with much smaller quantities (1 to 2 ounces versus one quart per gallon of fountain solution) alcohol substitutes would not present any impact upon present disposal methods.

4.4 SOLID WASTE DISPOSAL

No solid waste would be generated by reducing the use of isopropyl alcohol or other high volatility organic compounds in dampening system fountain solutions.

4.5 ENERGY REQUIREMENTS

No change in energy requirements would result from reducing the level of fountain solution alcohol content.

4.6 REFERENCES

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5.0 CONTROL COST ANALYSIS OF RACT

This chapter discusses the costs incurred by offset printing plants upon implementation of RACT. There are no capital costs associated with the reduction of alcohol from dampening system fountain solutions. The cost impacts incurred result in a net cost savings attributed to reduced consumption of isopropyl alcohol. Section 5.1 discusses RACT costs estimated for the Model Plant discussed in Section 2.4. Other RACT cost considerations are discussed in Section 5.2.

5.1 RACT COST ANALYSIS

The costs incurred by an offset printing plant to implement RACT controls may vary depending upon several factors, just a few of which include: the existing levels of alcohol used in the fountain solution, the number of offset presses at the plant, the type of printing performed (e.g., line or dot images), and the type of alcohol substitute chosen to reduce the VOC content of the fountain solution to or below 10 weight percent. Estimated typical RACT costs under two scenarios are given in Table 5-1 for the Model Plant assuming (1) a phased VOC (alcohol) reduction and (2) the immediate total elimination of alcohol from the fountain solution.

RACT requires all offset presses to reduce the VOC content of fountain solutions to at least 10 weight percent initially and to submit a 12-month plan to achieve the equivalent emission reductions based on a fountain solution containing no more than 5 weight percent VOC. Many facilities will likely gradually reduce the alcohol content of their fountain solution. Under this approach the Model Plant would incur a net annualized cost savings estimated in Table 5-1 at $3,390 and $4,990 for the first and latter years of implementation, respectively.

Yet, some facilities may opt to reduce the VOC content of the fountain solution to 5 weight percent or totally eliminate the use of alcohol immediately. Total elimination of alcohol would result in an estimated net annualized cost savings to the Model Plant of $7,910.

TABLE 5-1. ANNUALIZED MODEL PLANT RACT COSTS (Based on April 1985 dollars)

Cost Item, $/yr	Phased Alcohol Reduction: Reduction to 10 Weight Percent VOC	Phased Alcohol Reduction: Reduction to 5 Weight Percent VOC	Total Alcohol Elimination
Alcohol Substitute[a]	4,650	6,975	9,300
Labor[b]	330	1,000[c]	330
Lost Production[d]	820	820	820
Alcohol Reduction[e]	(9,190)	(13,785)	(18,380)
Net Annualized Cost	(3,390)	(4,990)	(7,930)

(xx) = denotes cost savings.

[a]From Table C-1, the cost for alcohol substitutes is based on 1,760 liters for a reduction to a 10 weight percent alcohol content in the fountain solution and 3,520 liters for total elimination of alcohol. Based on a cost of $2.64 per liter of alcohol-substitute compound. Reduction to 5 weight percent was estimated at 1.5 x cost of reduction to 10 weight percent VOC.

[b]A labor charge is included in the cost analysis because of the industry-wide concern with pressmen learning to operate presses under reduced alcohol levels. This cost item is an initial cost and, therefore, it is treated as a capital cost and annualized over a 10-year period. Allowing for 100 additional labor hours at a labor rate of $20/hour, the capital recovery cost for the initial labor cost would be (assuming 10 percent interest):

capital recovery cost = (initial cost)(0.163) = ($2,000)(0.163) = $330.

[c]Assumes plants will incur additional labor costs (estimated at 2 x $330) to learn to operate at lower alcohol content, first at 10 weight percent VOC and again at 5 weight percent VOC. Costs for reduction to 5 weight percent VOC. Costs also include the development and submission of a plan outlining strategies to achieve further emission reductions. The plan costs are estimated at approximately $2,700 or an annualized cost of $440.

[d]Estimated based on 2-hours of lost production time. Assuming the model plant annual sales are $15 million, then a worst case cost estimate of 2-hours lost production can be approximated as:

(2 hrs) ($15,000,000/yr)/(6,000 hrs/yr) = $5,000

the annualized cost of lost production =

capital recovery cost = (initial cost)(0.163) = ($5,000)(0.163) = $820.

[e]From Table C-1, alcohol reductions would be 18,750 liters for reduction to 10 weight percent alcohol and 37,500 liters for total alcohol elimination. Based on a $0.49 per liter credit for isopropyl alcohol. Reference 1. The alcohol reduction credit does not include credit for other benefits such as increased plant safety, lower insurance costs, and reduced storage costs. Reduction to 5 weight percent VOC estimated at 1.5 x cost of reduction to 10 weight percent VOC.

5.2 OTHER RACT COST CONSIDERATIONS

As mentioned previously in Chapter 3.0, several hundred offset lithograph facilities are already using substitute compounds, either to extend the use of alcohol or to totally eliminate the need for alcohol in the fountain solution. These facilities demonstrate that print quality can be maintained through the use of alcohol extenders and that there is an economic justification for their use in the absence of environmental regulations. Other less tangible cost benefits from the use of alcohol-substitutes include increased plant safety and, hence, lower insurance costs. Another cost savings that would be realized is that of lower storage costs, since much less isopropyl alcohol would be necessary at the printing plants.

The cost analysis presented in Table 5-1 included estimates for the additional labor costs incurred by facilities in training pressmen to operate presses with reduced levels of alcohol, increased press maintenance, and lost time to come "back-to-color." The cost analysis also includes a worst case cost estimate for lost production time. Many offset presses have switched to reduced levels of isopropyl alcohol without loss of production or increased waste, however, other presses have experienced a few temporary shutdowns (for example, 1/2 to 1 hour downtime each). To estimate a worst case cost for lost productivity during the initial transition, the downtime cost was derived as a proportion of the plants total annual sales, 15 million dollars.[2] As shown in Table 5-1, assuming 2-hours total lost production time, the cost of lost production would represent $5,000 ($820 annualized cost). These costs may vary among facilities as reflected by the varying pressmen skills (i.e., operators v. journeymen) printing schedules, substrates and type of printing (line or dot image); however, these added costs are held to be temporary costs.

5.3 REFERENCES

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APPENDIX A

MODEL REGULATION

A.0 MODEL REGULATION

1200-3-18-___ OFFSET LITHOGRAPH PRESSES

(1) For the purpose of this rule, the following definitions apply:

(a) "Fountain solution" - means the solution of water, gum arabic, etchant, and surfactants used for wetting a lithographic press plate.

(b) "Lithography" - means the printing process in which the printing and non-printing surfaces are on the same plane.

(c) "Offset" - means the lithographic printing process in which the printing image is transferred from an image plate to a rubber blanket cylinder before transfer to the printed substrate.

(2) Owners or operators of an offset lithograph press shall not use a fountain solution containing greater than 10 weight percent VOC at any time.

(3) Owners or operators of an offset lithograph press shall submit a twelve-month program to achieve further emission reductions. At a minimum the program shall:

(a) Include strategies to demonstrate the equivalent emission reduction to 5 weight percent VOC in the fountain solution;

(b) Include other strategies for demonstrating the feasibility of achieving 100 percent alcohol substitution (said strategies must be demonstrated on at least one offset lithograph press per printing plant);

(c) Within six months of the completion of Part 3(b), the affected plant shall use a 100 percent alcohol-free fountain solution, or a fountain solution containing the lowest alcohol content demonstrated feasible under item 3(b).

(4) Owners or operators of an offset press shall be subject to the following operating practices:

(a) All containers holding VOC materials shall be open only when necessary and openings shall be restricted to the extent feasible; and

(b) The leaking of any VOC or VOC-containing material from any offset press or associated equipment shall be prohibited.

APPENDIX B

ENFORCEMENT ASPECTS

B.0 ENFORCEMENT ASPECTS

B.1 INTRODUCTION

Determination of compliance with the model regulation will require periodic inspection by enforcement personnel and testing of fountain solution compositions. Section B.2 presents information on test methods applicable to determining compliance with requirements pertaining to the fountain solution. Section B.3 discusses enforcement aspects associated with the good housekeeping practice requirements of the model regulation.

B.2 FOUNTAIN SOLUTION

Compliance with the model regulation pertaining to the fountain solution will require analysis of volatile organic content. The test method used will need to assess weight percent VOC. Determination of VOC content of the fountain can be determined if accurate records are maintained by printing facility subject to RACT requirements. These records would include the quantities of all components that comprise the fountain solution and the chemical composition of each component; for example: water, isopropyl alcohol, alcohol-substitutes, gum, etchant, etc.

In the absence of good records (and/or as a verification of plant records), enforcement personnel may need to utilize an analytic test method to determine compliance with the model regulation. The American Society for Testing and Materials (ASTM) standard test method for Total and Organic Carbon in Water (D 2579-78) provides two applicable approaches: Method A - Oxidation-Infrared Detection and Method B - Reduction-Flame Ionization Detection.

B.3 GOOD HOUSEKEEPING PRACTICES

Determination of compliance would include a visual inspection of printing facilities subject to the model regulation. The enforcement personnel performing the inspection would observe containers holding VOC such as the fountain solution mixing tank, large storage tanks and containers, cans used to hold cleaning compounds, etc., to observe whether such containers were properly covered and whether necessary

opening of these containers were restricted to the minimum extent feasible. Inspectors would also look for evidence of leaking VOC from any offset press or associated equipment.

APPENDIX C

ALCOHOL SUBSTITUTES

C.0 ALCOHOL SUBSTITUTES

C.1 INTRODUCTION

The purpose of this appendix is to provide additional information on the basis of cost calculations both to reduce and eliminate the use of isopropyl alcohol in dampening system fountain solutions. Section C.2 provides information regarding the quantity and type of alcohol substitutes required for the Model Plant presented in Section 2.4 to operate at 10 weight percent alcohol and total elimination of alcohol scenarios. Section C.3 presents cost information and the basis for the cost estimates presented in Chapter 5.0.

C.2 QUANTITY OF SUBSTITUTES

Plants subject to implementation of RACT may do so by immediately eliminating all isopropyl alcohol or gradually, by initially reducing the fountain solution to 10 weight percent alcohol. Under either scenario, the amount of alcohol-substitute required is proportional to the alcohol being replaced. The amount of substitute compound per unit alcohol reduction is dependent upon the type of substitute used.

As discussed in Chapter 2.0, the fountain solution is comprised of several components (in addition to alcohol), principally, an etchant and gum arabic. Alcohol substitutes may possibly be used in conjunction with existing etchant and gum components,[1,2] or changing the gum and arabic may complement the substitute to further alcohol reductions.[3]

Typical offset presses presently run on an "1:1:1 system," that is, one ounce of etch and one ounce of gum to a gallon of water which is then combined with alcohol to about a 20 to 25 weight percent alcohol fountain solution. For each gallon of fountain solution, hence, about one quart of isopropyl alcohol is used. By using an alcohol substitute each quart of alcohol replaced would require between one and three ounces of substitute compound, or a ratio of 12 ounces per gallon isopropyl alcohol reduced based on an upper estimate.

Most substitute vendors have or are presently developing "one-step" substitutes that combine gum, etchant, buffers, fungicides, etc. The attractiveness of the one-step solutions is elimination of the

need for precise measurement of each component. One vendor's one-step substitute is used at a rate of 5 ounces per gallon of water. This is an effective replacement rate of 1 gallon of alcohol, 4 ounces of etchant and 4 ounces of gum for 20 ounces of one-step substitute.

For the purpose of estimating the amount of alcohol substitute required for the Model Plants as shown in Table 5-1, it was assumed that 12 ounces of substitute compound are required per gallon of isopropyl alcohol reduction. These calculations are presented in Table C-1.

C.3 COST OF SUBSTITUTES

The costs of available substitutes varies as to the plants' decision to: (1) use existing etch and gum components with an alcohol substitute; (2) switch to a new gum and etchant with an alcohol substitute; (3) use a one-step solution; and (4) whether to gradually or totally eliminate alcohol from the fountain solution. Approximate costs for gum and etchant are $10 each. Alcohol substitutes may range between $7 and $16 per gallon, with lower pricing rates offered for larger purchases (e.g., three or more 55-gallon drums). A vendor of a one-step substitute solution estimated a cost of $7 F.O.B. Lake Bluff, Illinois. For the purpose of estimating the cost of alcohol substitutes a price of $10 per gallon or $2.64 per liter was assumed. Accordingly, the Model Plant costs under the two scenarios presented in Table C-1 would be approximately $4,650 for an initial reduction to 10 weight percent alcohol and $9,300 for total alcohol elimination.

TABLE C-1. CALCULATION OF ANNUAL ALCOHOL SUBSTITUTE REQUIREMENTS

Model Plant Parameter	RACT Scenario	
	Reduction to 10 weight percent	Total Alcohol Elimination
Alcohol used before RACT,[a] liters/yr	37,500	37,500
Alcohol used after RACT, liters/yr	18,750[b]	0
Alcohol reduction, liters/yr	18,750	37,500
Substitute requirement,[c] liters/yr	1,760	3,520

[a]Represents alcohol evaporative loss from dampening system. From Table 2-2: 50,000 liters - 12,500 liters = 37,500 liters (9,900 gallons).

[b]Based on a 50 percent reduction.

[c]Based on 93.8 milliliters of substitute per liter of alcohol reduction (12 ounces substitute per gallon of alcohol reduction).

C.4 REFERENCES

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